PATENT SPECIFICATION

DRAWINGS ATTACHED

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Int. Cl.: —B 32 b

COMPLETE SPECIFICATION

Improvements in or relating to Laminated Plastic Sheets

We, FORMICA INTERNATIONAL LIMITED, a British Company of 84/86 Regent Street, London, W.1, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to laminated metal-plastics sheets and to processes for making the same. More particularly it relates to flat decorative laminated sheets which although eminently suitable for application to flat surfaces by means of adhesives are of such a nature that they can be readily bent round and adhere to curved surfaces of small radii.

Articles of commerce in the form of sheets consisting entirely of synthetic resins, or of non-resinous sheets, especially sheets of fibrous material, impregnated or coated with synthetic resin, are well known. Such articles may be single sheets or may be the result of the combination under pressure of at least two laminae with or without adhesives of various kinds; the laminae may be combined by activation by solvents on at least one of the surfaces to be joined, or by welding or simple pressure techniques, with or without the application of heat. The resins employed may be thermosetting or thermoplastic or both types together. It is also known to combine metallic layers and one or more sheets of synthetic-resin-containing materials for the purpose of producing an article of improved strength or for various utilitarian purposes; for example (1) decorative laminates of the thermosetting type are commonly provided with a layer of aluminium foil beneath the decorative components in order to dissipate the heat of an article, e.g. when a cigarette end is placed on the outer surface of the laminate, (2) thermosetting laminates having good electrical properties are manufactured with one or more external layers of copper foil so that printed circuits can be produced by etching away unwanted portions of the metal, and (3) structural steel sheeting may be provided with a surface layer of polyvinyl chloride in order to produce a decorative and corrosion-resistant material.

The flexibility of synthetic-resin-containing sheet materials varies over a wide range. In such materials flexibility is a function of a number of different characteristics of the laminate, for example, its thickness, the nature, quantity and cure of the resin, and the flexural characteristics of any non-resinous components; thus, for example, (1) a constructional grade of laminate made wholly of sheets of fabric impregnated with a phenolic resin and of a thickness of one inch is hardly capable of being bent at all, (2) a decorative laminated plastic having a melamine resin surface and a phenolic resin core and of a thickness of one sixteenth of an inch is capable of being bent round a curve of only five or six inch radius (unless it is subjected to an elevated temperature for the carefully controlled periods as required in certain post-forming techniques), and (3) a printed sheet of polyvinyl chloride 0.004" thick is capable of being bent around curves of very small radii. It is to the general type of decorative sheet material exemplified by "(3)" that this invention mainly relates, for there is a commercial need for an improved high-quality resonous decorative surface-covering material.

In order to produce flexible synthetic-resin-containing sheet or resinous laminated materials, it is necessary not only to select a suitable

[*Price* 4*s.* 6*d.*]

thickness but also to use resins and a support or carrier or reinforcing material both of which are flexible in their own right as well as when in combination one with the other. However, the bending of such materials around curves or even around right-angled bends and the simultaneous bonding of the material to the curved or angled surface presents considerable difficulties, for although the materials in question possess the desirable property of flexibility they are also invariably resilient. By a "resilient" material we mean, in the present description and claims, a material which, when acted upon by an external force and thus caused to be deformed from its original shape, will return or tend to return to its original shape upon removal of the force, provided the material has not been deformed beyond its elastic limit. By a "flexible" material, on the other hand, we mean, in the present description and claims, simply a material that will bend without breaking.

Decorative synthetic-resin-containing sheet or laminated materials which have the property of resiliency, though they may present no problems when they are to be applied to flat surfaces, may yet give great difficulty if they are to be adhered to curved surfaces; their recovery characteristics are such that, almost irrespective of the adhesive used, it is necessary to hold the sheet or laminate positively in place, in its deformed shape, until the adhesive has set. If the resilient sheets are adhesively fixed to a surface by the so-called "impact" adhesives, the "spring-back" of the material may even be strong enough to make adhesion by such adhesives impossible under their recommended conditions of use. The need to hold the sheet or laminated materials in their deformed shapes around for example the curved edges of window sills, pillars, or table legs, for the period that the adhesive requires to become effective, consumes so much time that for economic reasons the materials are not used as much as their cost, durability and attractiveness would otherwise allow.

It is an object of this invention to provide a laminate comprising a flexible synthetic-resin-containing sheet material which comprises or incorporates at least one sheet of material having the property of resiliency, in which the resiliency of that sheet is counteracted, so that, under the action of an adhesive for bonding the laminate to a curved substrate, the laminate will assume the shape to which it is deformed irrespective of the condition of the adhesive.

According to this invention, a laminated metal-plastics sheet capable of permanent deformation, as hereinafter defined, comprises at least one resilient sheet material which comprises a fibrous sheet coated or impregnated with a synthetic resin adhesively bonded to at least one flexible metal sheet of substantially the same area and having a thickness of 0.005 to 10 times the thickness of the resilient sheet.

By a laminated metal-plastics sheet "capable of permanent deformation", we mean, in the present description and claims, one which on being deformed by its original shape by an external force is held in the deformed shape, upon the removal of the external force, and against restoring forces exerted by the plastics constituent, by the metal constituent.

A single resilient sheet may be bonded to one side of a single metal foil, but the invention also includes articles in which a series of the resilient sheets are bonded to a series of metal sheets in an alternating arrangement, and in such cases the outer sheets may be resinous or metallic. Alternatively a series of the resilient sheets can be bonded to a series of the metal sheets in a non-alternating or non-regular manner so that two or more of the former sheets or two or more of the metal sheets are bonded in contact with each other.

The resilient sheet may comprise, as specified earlier, a fibrous sheet which has been either coated or impregnated with a synthetic resin. The resins may be thermosetting or thermoplastic. Suitable resins include all those synthetic resins which, by themselves in sheet form or when coated on or impregnated into the surface of a flexible fibrous sheet, will respectively possess or will impart to the sheet the power or returning to the original shape after being released from a deforming force. Naturally, certain resins are more resilient than others, and certain other resins are so brittle or non-deformable that they are not resilient at all. For the purpose of the present invention, it is desirable that the resilient sheets specified should each be capable of returning to its original shape after it has been bent without cracking or fracturing its surface round a radius of not less than 1/16 inch, and that they should retain this property of resiliency when they are combined with a metallic sheet to form a composite product; preferably the resiliency is retained in the non-deformed condition and preferably also for long periods of time when held in a position out of the original shape. The synthetic resin with which the fibrous sheet is coated or impregnated may for example be a phenol-formaldehyde resin, a urea-formaldehyde resin a melamine-formaldehyde, modified melamine-formaldehyde, or other aminotriazine formaldehyde resin, or another aldehyde resin; a polyester resin; an epoxy resin; a substituted or unsubstituted vinyl resin; an acrylic resin; or a mixture of any two or more of these resins. Preferably the thickness of the resilient sheet material is of the order of 0.04" and the thickness of the metal sheet is between 0.05" and 0.0002". Preferably the metal of the metal sheets is of such a nature

that upon applying a force sufficient to bend the composite product round a radius not less than 1/16 inch the yield point of the metal is reached with the result that the laminated article will retain the new shape until it is acted upon by another external deforming force.

In preferred embodiments of the invention, a sheet of paper provided with a decorative pattern on its outer surface and impregnated with a thermosetting resin, e.g. a cross-linked polyester resin, is combined with a layer of metallic foil High-grade relatively heavy papers, for example, those weighing between 80 gms/sq. metre and 200 gms/sq. metre, are particularly useful, and resin contents of between 30% and 80%, e.g. between 35% and 70%, and particularly between 45% and 60%, by weight of the treated paper give durable products of good appearance.

The resiliency of the resilient sheets must be capable of being counteracted by the presence of the metal sheet in the laminate without, however, damage being caused or permanent deformation being imparted to said flexible sheets themselves. Hence it is generally advisable that the metallic foils should have comparatively low yield points, i.e. yield points which are comparatively low in the field of metals, and that the resin sheets should have comparatively high yield points, i.e. yield points which are high in the field of resins, and although soft-tempered aluminium foil is particularly suitable other foils can be used, for example foils of lead, tin, zinc, soft copper, brass, nickel, indium, gallium or suitable alloys of those metals. Aluminium foils a few thousands of an inch thick, e.g. aluminium foil of 0.002" thickness, are particularly suitable on account of their cheapness. The ultimate tensile strength of the metal of the metal sheets must also be greater than that of the flexible resin-containing sheets. A preferred range of ultimate tensile strength is between 300 and 120×10^3 lbs. per square inch values between 3×10^3 and 16×10^3 lbs. per square inch being particularly preferred. The yield point is preferably less than 115×10^3 lbs. per square inch, values between 12×10^3 and 20×10^3 lbs. per square inch being particularly preferred.

The metal sheet is preferably formed of aluminium in any convenient gauge of say from 0.0002 inches in thickness up to 0.05 inches and of any convenient temper from "full hard" to the completely annealed "dead soft". To give a laminated article which will keeps its shape in its deformed configuration, the commercial pure, "dead soft" aluminium foil of approximately 0.0035 of an inch is preferably used in the case of the present invention. Good adhesion is required for bonding the metal to the resilient sheet material, and certain treatments may be advisable in the case of metal foils which form or possess a coating which is resistant to forming a strong bond, for example, the oxide layer present on the surface of aluminium, which may additionally have grease patches on the surface due to handling or manufacture, for instance. The treatments to which it may be advisable to subject the metal foil are surface-activation treatments, for example chemical etching, mechanical etchings and other treatments which increase the effective surface area of the foil to be bonded.

The combination of the metal sheets and the resilient sheets may be effected by means of a continuous laminating process. The metal sheet may be coated with the same resin as is used with the fibrous sheet, but conveniently the resin-containing sheets are fully impregnated so that the metal adheres to them under the heat and pressure conditions of the laminating process. Alternatively, any suitable adhesive may be used to bond the metal and resilient components either in-situ during the formation of said sheets or in a second operation after they have been formed. The surface of the metal which is to be bonded may in any case be modified as mentioned above to facilitate adhesion, e.g. by chemical etching, mechanical etching or other treatment which increases the effective surface area of the foil to be bonded.

The adhesion of the exposed metallic surface to a substrate can be achieved by any suitable system, but we prefer to use adhesives of the impact of pressure-sensitive types. The exposed metallic surface may be coated with a pressure-sensitive adhesive either immediately after a continuous laminating process and on the same apparatus or alternatively in an entirely separate operation. Permanently tacky adhesives which will adhere to any suitable untreated substrate by the mere application of pressure can be used but we prefer to provide the metal with a coating of a natural rubber adhesive which has the property of being tack-free; in such cases it is necessary to coat the substrate with a similar emulsion which when dry is also tack-free but when the coated metal is brought in to contact with the coated substrate an immediate and effective bond is established. In all cases where the rear face of the laminate is provided during manufacture with an adhesive coating it is preferable (if not essential) to cover the adhesive with a backing material which can readily be removed before the laminate is adhered to a substrate. The following is a specific adhesive system which has given particularly good results:—

Primer: a filled rubber/resin solution, 40—70% solids, and diluted before application to the laminate to 20—40% by weight. This is coated on to the laminate first followed by the main adhesive—

Main adhesive: a rubber latex emulsion, 50—70% by weight solids.

User Adhesive (applied by the customer): a rubber/resin solution, 10—30% solids. This is a brushable adhesive having an "open" time of about 10 minutes and it bonds satisfactorily to most substrates, including metals and glass.

Laminates according to this invention are normally capable of being bent round curved surfaces having radii as small as 1/16 inch and of retaining their deformed configurations in the presence of an adhesive between the backs of the laminates and the front of the curved surfaces.

Apparatus for producing certain laminates in accordance with the invention will now be described by reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic view in side elevation of one form of laminate-making machine, and

Figure 2 is a similar diagrammatic view of a machine for applying adhesive and backing to the laminate from the machine of Figure 1.

In the machine of Figure 1, a sheet of paper 1 printed on its upper surface with a decorative pattern is passed at a rate of 8 feet per minute from a reel 2 over guide rollers 4, 5 to resin-coater compartment 6 which contains in trough 7′ a solution of a polyester resin from tank 3, a resin-coater roller 7 and a drive roller 8. Polyester solution is continuously recycled from tank 3 to the resin-coater compartment 6 by means of a pump (not shown) in tank 3, via an outlet pipe 9 and a return pipe 10. The resin-coated sheet passes between rollers 11, 12 where it is joined on the upper surface by an inert separating sheet 13 of "Cellophane" from reel 14 on stand 15 and on the lower surface by a sheet of aluminium foil 16 from reel 17. The stand 15 contains a spare reel 18 serving for the replacement of either of the two reels 2, 14, when necessary, and without stopping production. The inert sheet 13 is subsequently removed from the aluminium and resin-coated plies by winding the sheet on to reel 19. On leaving the rollers 11, 12 the triple ply of material passes over guide rollers 20, 21 and 22 to a heated rotating drum 27, against which it is held by an endless steel belt 23. The belt 23 is held in tension by passing over an adjustable roller 24, rollers 25 and 26, and the drum 27, with external heater 35′. The triple ply is carried round between the belt 23 and the drum 27 with the inert sheet adjacent to the drum 27. On leaving the heated drum 27 the triple ply passes back towards a series of rollers 28, 29, 30 where the inert sheet is removed from the two bonded layers, i.e. the aluminium layer 16 and the paper printed layer 1. The inert sheet is stored on roller 19 and the bonded material shown at 31, after trimming, is removed from roller 32, inspected on passing around roller 33, and stored on roller 34. The external heater 35 comprises a 45-kilowatt electrical heating element mounted close to the drum 27 to supply heat to the external aluminium layer beneath the steel band 23. However, the drum 27 can also have internal heating means, for example hot-water or steam passage. The bonded material 31 wound upon roller 34 is transferred to an adhesive coating unit.

The adhesive coating unit is illustrated in Figure 2. Thus the two-ply bonded material 31 on the roller 34 of Figure 1 passes around guide rollers 36, 37 and through a roller-coater represented by rollers 38, 39 to apply a primer adhesive coating to the surface of the aluminium foil. The primer adhesive coating is dried in a drying oven 40 to remove the solvents present in the primer adhesive and the dried primer-coated material 31 passes around roller 44 to an adhesive coater 45. The adhesive coater is actuated by motor 46 which transmits power via a series of belts which pass over drive connecting rollers 47, 48 to roller 49. The roller 49 operates via "V" belt rollers 50, 51 and roller adhesive coater 52. Motor 46 also actuates a rewind reel 53 via drive connecting rollers 47, 54, as well as the primer adhesive coater via drive connecting rollers 47, 55 and 56. The material 31 on leaving the adhesive coater 45 passes over an idle roller 44′ through an adhesive drying oven 57 with a common exhaust stack 58 with the primer drying oven 40, and passes over guide roller 59 where a protective and readily removable layer of polyethylene film 60 from reel 61 is superimposed on the dried adhesive surface of the metal. The triple-ply material shown at 62 then passes over guide roller 63 through trimmers 64, 64′, and over guide roller 65, and is stored on reel 53.

One of the many embodiments of the invention is described in the following example.

Example

A two-ply laminate was produced using the apparatus described in conjunction with Figure 1. The paper 1 comprised a roll 50 inches wide, of 130 gms/sq. metre paper, 0.006″ thick, which had previously been printed on its internally wound side with a red and yellow line-and-dot pattern from an epoxy-resin based ink. The reverse coater unit was supplied with a liquid isophthalic polyester resin of specific gravity of 1.10 at 21° C and acid value of 16 mg KOH per gram, the setting of the resin was catalysed by the addition thereto of 1% by weight lauroyl peroxide. The roll 16 was of soft-tempered aluminium foil 0.002″ thick and 51 inches wide and the roll 13 was of "Cellophane" regenerated cellulose 52 inches wide ("Cellophane" is a registered trade mark). The weight of resin carried by the impregnated sheet 1 was 45% of the total weight of the

impregnated paper, and the decorative component of the laminate on its passage around the drum 27 was cured at 95° C; the speed of the paper through the machine was 1.5 ft. per minute. The trimming unit cut off the edges of the laminate to give it a width of 48 inches before it was wound up on the take-up roll 34.

The roll 34 was then removed from the machine and passed through a treating machine which coated the metallic surface successively with an emulsion comprising filler, natural rubber latex and hydrocarbon solvent, and, after drying, with a rubber latex/water emulsion. After drying, a sheet of brown backing paper was laminated on to the rubber coating.

A sheet 108 inches long was cut from the roll and the "Cellophane" and brown paper outer layers were removed. The surface of a table having vertical and slightly rounded side edges was coated with "Bostik 20 S" which was allowed to dry and then the decorative sheet was applied to the coated surfaces. The sheet was easily bent so that the sheet cover not only the top of the table but also the side edges, and by a single application of a light pressure, permanent overall adhesion was achieved.

The term polyester resin as used herein in a general sense includes all those resinous products that comprise a polymerisable saturated or unsaturated polycarboxylic-acid-polyhydric-alcohol type of polyester which is prepared by an esterification reaction between one or more polycarboxylic acids and one or more polyhydric alcohols. In order to either control or increase the curing or hardening of polyester resins, a catalyst or reaction promoter, which may be a peroxy-compound, e.g. benzoyl peroxide, is commonly added before the application of resin, and it is understood that such catalysts, promoters or accelerators may be used with the polyesters of the present invention. Other suitable promoters are metal compounds such as cobalt naphthenate, iron naphthenate and ferrous phenanthroline complexes; bases; amines such as diethylaniline and dimethylaniline; quaternary salts; Lewis acids such as ferric chloride and perchloric acid; and certain mercaptans, e.g. 2-mercapto-ethanol. These catalysts and promoters may be used in association with other additives, the most common of which for decorative laminated articles are pigments, e.g. TiO_2 or cadmium pigment, and/or other materials such as dyes, inert fillers, for example SiO_2 and/or finely divided cellulose fibres. The appropriate catalysts or promoters are chosen for each polyester resin system in order to obtain the most satisfactory results for coating on to the fibrous sheet materials, and the choice of additives (such as the pigments referred to above) is dependent on whether or not they inhibit the action of the catalysts or promoters. It is preferred to use promoters for the cold-setting material only.

A particularly suitable polyester resin can be prepared in accordance with known methods by the following procedure. First a mixture of 24% maleic anhydride, 36% phthalic anhydride and 40% propylene glycol is heated in an atmosphere of CO_2 and at 210° C. for 8 hours. 35 parts of styrene are then added to 65 parts of the reaction mixture (with 0.015% hydroquinone as an inhibitor). (These percentages and parts are by weight).

A promoter composition is next prepared separately from 100 parts by weight of methyl cellosolve (i.e. 2-methoxy-ethanol), 25 parts (wt.) benzene-phosphonic acid and 5 parts (wt.) of a 10% solution of vanadium naphthenate in dioctylphthalate. The vanadium naphthenate is added to the methyl cellosolve at 80°—100° F with agitation and the benzene-phosphinic acid is added to the reacted mixture at 80—100° F. A resinous solution comprising 85 parts of the above polyester resin (wt.), 15 parts of styrene, 1% (of total composition) cumene hydroperoxide, 0.25% benzoyl peroxide (of the total composition) and 0.25% of promoter is then used to coat a continuous sheet of fibrous material as described in connection with Figure 1.

An alternative resinous composition comprises:—

100 parts by weight of liquid isophthalic polyester (of acid value 16 mg. KOH per gram and specific gravity of 1.10 at 21° C)

2 parts by weight of catalyst (e.g. benzoyl peroxide).

7 parts by weight of a diluent (e.g. styrene monomer).

The above ingredients give a liquid resinous mixture with the properties of:—

Viscosity: 550 ± 50 Centistokes at 25° C.
Gel time: $3.5 \pm \frac{1}{2}$ minutes
Cure time: $4.5 \pm \frac{1}{2}$ minutes
Peak temperature: $460 \pm 10°$ F

The resin mixture gels in 2.8 minutes at 80° C and cures in 3.8 minutes with an exothermic temperature peak of 260° C.

Another particularly suitable composition is an epoxy resin which may be prepared by the following procedure. First 90 parts (by weight) of an epoxy resin known as "Epikote 828" and sold by the Shell Company and 30 parts (by weight) of a flexible epoxy resin known as "DER Resin 732" and sold by the Dow Company are reacted together with 20 parts of piperazine as a curing agent (The word "Epikote" is a registered Trade Mark). The mixture after application to both the fibrous sheet and the metal foil is cured for two hours at 85° C.

Laminates according to this invention, notwithstanding their particular advantages in decorative applications and their usefulness for covering curved and angled surfaces, may

find either additional or alternative uses on account of the presence of the metal components. Thus they may be used primarily as damp-proof liners for walls, or, when they include a combination of resins and fillers which are electrically insulating, they may be used as space-heating elements, the metallic component being connected to a suitable source of electrical supply.

Finally, the following details are given as being representative of the properties obtainable in a laminate in accordance with the present invention:—

Surface Finish: Matt

Cutting: Easily cut with scissors or a sharp blade.

Flexibility: Capable of bending to radius of between 1/8" and 1/16".

Heat resistance: Unaffected by hot teapot or (for at least 300 seconds) a lighted cigarette.

Stain-Resistance: Resistant to all household stains, except iodine and phenol.

The laminate also has good shrinkage-resistance, scratch-resistance, wear-resistance, colour stability, and resistance to damp and water.

WHAT WE CLAIM IS:—

1. A laminated metal-plastics sheet capable of permanent deformation, as hereinbefore defined, comprising at least one resilient sheet material which comprises a fibrous sheet coated or impregnated with a synthetic resin adhesively bonded to at least one flexible metal sheet of substantially the same area and having a thickness of 0.005 to 10 times the thickness of the resilient sheet.

2. A laminated sheet in accordance with claim 1 wherein the resilient sheet material is a sheet of paper provided on its outer surface with a decorative pattern and impregnated with a thermosetting resin.

3. A laminated sheet in accordance with claim 2 wherein the thermosetting resin is a cross-linked polyester resin.

4. A laminated sheet in accordance with any of claims 1 to 3 wherein the fibrous sheet in the resilient sheet material is a paper weighing 80 to 200 gms/sq. metre and the resin content is 30% to 80% by weight of the paper.

5. A laminated sheet according to any of claims 1 to 4, wherein a metal sheet is sandwiched between and adhesively bonded to two resilient sheets.

6. A laminated sheet according to any of claims 1 to 4, wherein a series of the resilient sheets are bonded to a series of the metal sheets in an alternating arrangement, the uppermost sheet being a resilient sheet.

7. A laminated sheet according to any of claims 1 to 4, wherein a series of the resilient sheets are bonded to a series of the metal sheets in a non-alternating arrangement, the uppermost sheet being a resilient sheet.

8. A laminated sheet according to any of claims 1—7, wherein one outermost surface bears a decorative printed pattern and the other outermost surface is coated with adhesive.

9. A laminated sheet according to claim 8, wherein the adhesive is derived from an adhesive coating comprising a latex or other dispersion, or solution of a synthetic or natural rubber, with or without one or more stabilisers, wetting agents and/or inert fillers.

10. A laminated sheet according to either claim 8 or 9, wherein the adhesive coating is protected by a layer of inert sheeting.

11. A laminated sheet according to any of the preceding claims, wherein the resilient sheet material comprises a phenol-formaldehyde resin, a urea-formaldehyde resin, a melamine-formaldehyde, modified melamine-formaldehyde, or other aminotriazine formaldehyde resin, or another aldehyde resin; an epoxy resin; a substituted or unsubstituted vinyl resin; an acrylic resin; or a mixture of any two or more of these resins.

12. A laminated sheet according to any of the preceding claims, wherein the thickness of the resilient sheet material is of the order of 0.04" and the thickness of the metal sheet is between 0.05" and 0.0002".

13. A laminated sheet according to any of claims 1—12, wherein the total resin content of the (or each) resilient sheet is between 35% and 70% by weight.

14. A laminated sheet according to any one of claims 1—13, wherein the metal sheet has an ultimate tensile strength of between 300 and 120×10^3 lbs. per sq. inch.

15. A laminated sheet according to claim 14, wherein the metal sheet has an ultimate tensile strength of between 3×10^3 and 16×10^3 lbs. per sq. inch.

16. A laminated sheet according to any one of claims 1—15, wherein the metallic sheet has a yield point of less than 115×10^3 lbs. per sq. inch.

17. A laminated sheet according to claim 16, wherein the metallic sheet has a yield point of between 12×10^3 and 20×10^3 lbs. per sq. inch.

18. A laminated sheet according to any of the preceding claims in which the metal sheet is of aluminium, aluminium alloy, copper, brass, tin, lead, nickel, indium, gallium or a combination of any of these metals.

19. A laminated sheet according to any of the preceding claims, wherein the metal sheet is aluminium foil of 0.002" thickness.

20. A laminated sheet produced by a procedure substantially as described in Example 1 or Example 2.

21. A process for producing a laminated metal-plastics sheet capable of permanent deformation, as hereinbefore defined, which com-

prises attaching at least one resilient sheet comprising a fibrous sheet coated on impregnated with a curable synthetic resin to a flexible metal sheet by adhesively bonding the former sheet to the metal sheet by curing the synthetic resin whilst the sheets are in contact with each other under elevated temperature and pressure.

22. An apparatus for manufacturing laminated metal-plastics sheets capable of permanent deformation, as hereinbefore defined, comprising means for continuously treating at least one web of fibrous material with a synthetic resin, means for supplying one or more webs of metal foil in the direction of travel of said fibrous web or webs, means for bringing together said fibrous web or webs and said metallic web or webs in such a manner that upon the application of heat and pressure a unitary product is produced therefrom and means for applying a covering film to an external surface of the assembly of webs prior to said application of heat and pressure.

23. An apparatus according to claim 22, comprising means for applying an adhesive coating to the surface of the unitary product which does not carry said protective film.

24. An apparatus according to claim 23, comprising means for applying a readily removable sheet of protective material to said adhesively coated surface.

25. An apparatus for manufacturing laminated articles substantially as described above with reference to Figures 1 and 2 of the accompanying drawings.

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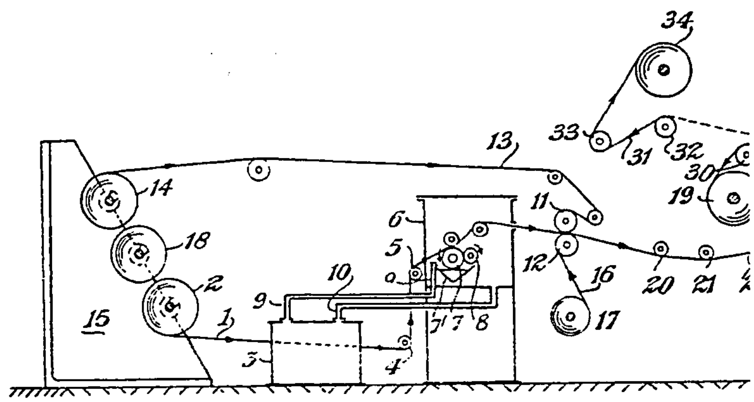
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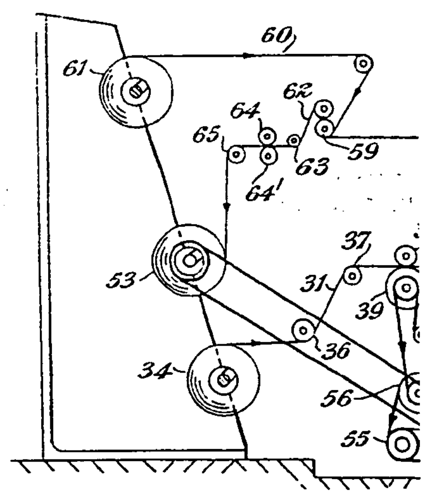
Fig. 1.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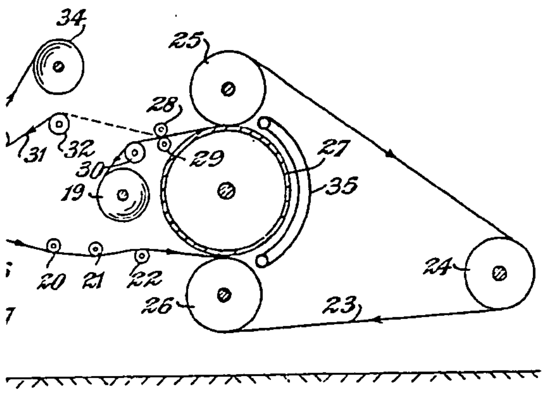

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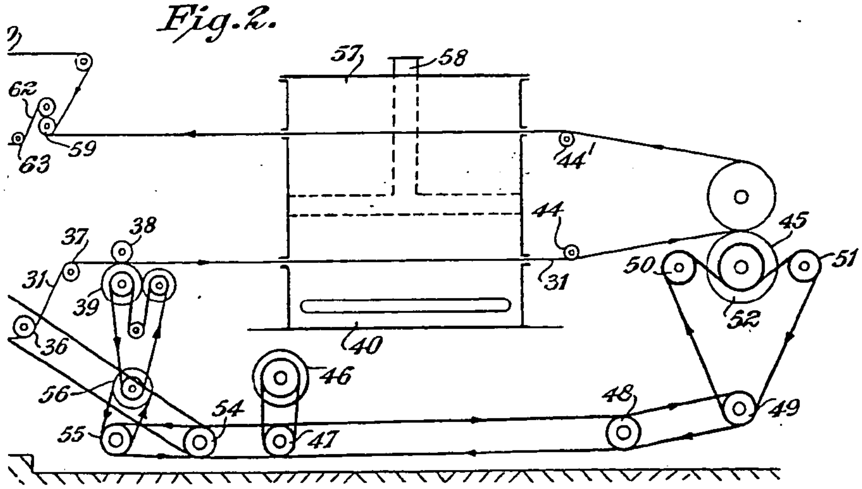
Fig.2.



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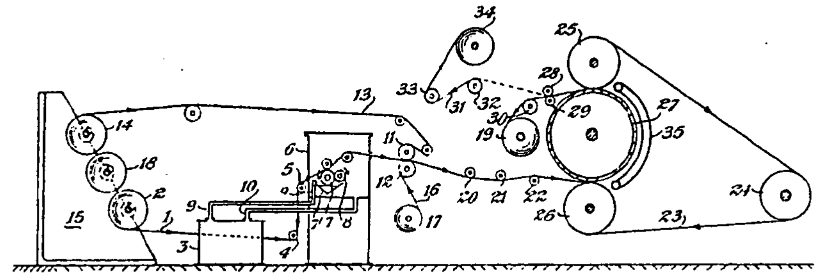

Fig. 1.

Fig. 2.